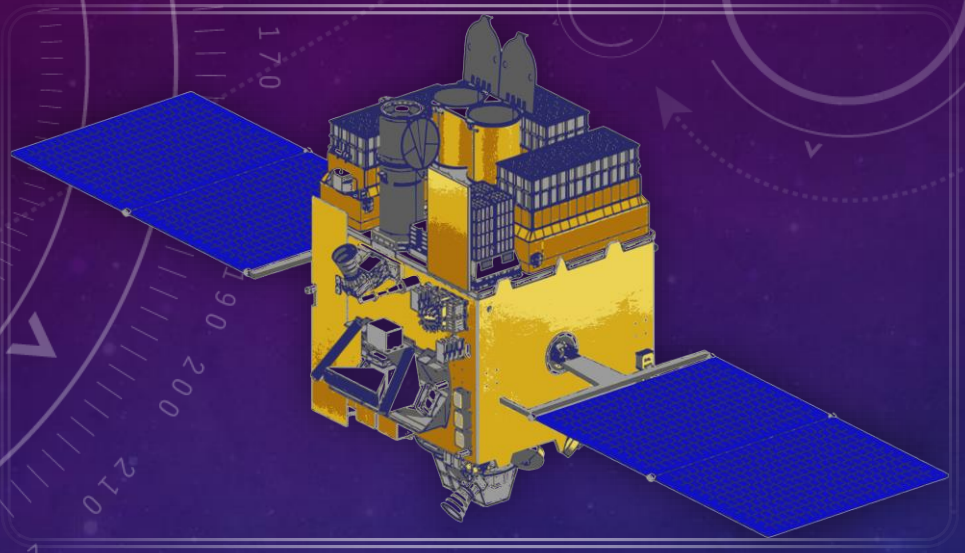


MASS MODEL OF ASTROSAT AND TRANSIENT DETECTION WITH CZTI

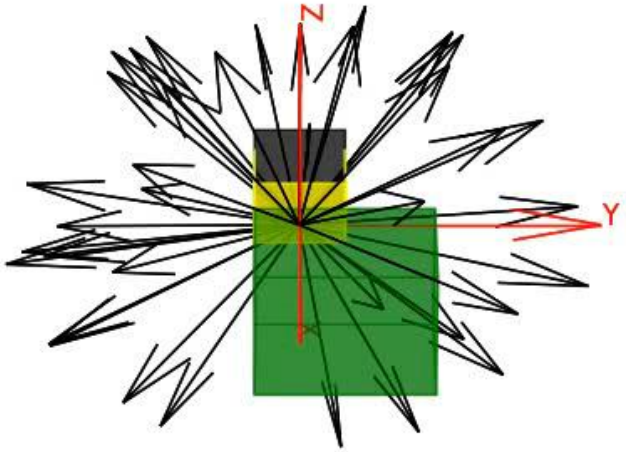
SUJAY MATE, IIT BOMBAY

(ON BEHALF OF CZTI INSTRUMENT TEAM)

INTRODUCTION

- AstroSat :
  - Maiden Indian space observatory
  - Five instruments, four co-pointed and one all sky monitor
  - Optical to hard X-rays
- CZTI :
  - Hard X-ray detector (20-200 keV) with coded mask
  - Acts as an all sky monitor above ≈ 100 keV
  - High sensitivity for majority of the sky → CZTI a good GRB detector
- CZTI has detected over 100 GRBs till now.
- This enables GRB science with CZTI which can give more insights about GRBs, especially about prompt emission.
  - Polarisation (Aarthy's Talk)
  - Spectra and Localisation (This talk)

GRB DETECTIONS WITH CZTI



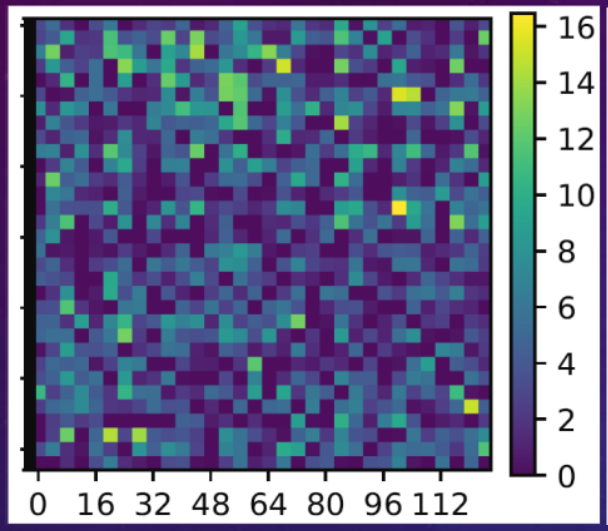
Credits : Dr. Varun Bhalerao

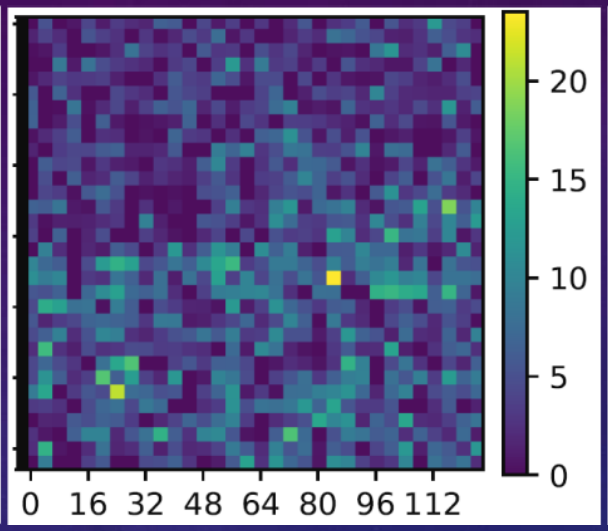
OFF AXIS RESPONSE OF CZTI

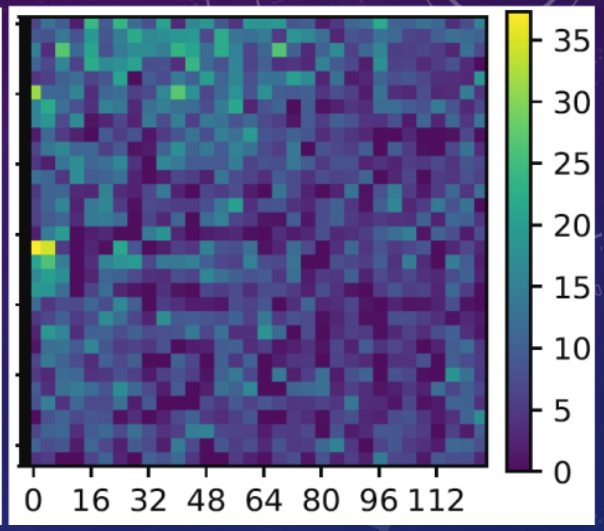
- Analysing off-axis sources is a non-trivial task due to the interactions of photons with the satellite elements.
- The direction and energy of photons is affected due to these interactions.
- The interactions are direction dependent as well as energy dependent.
- Also there is a dependence on chemical and geometrical properties of the interacting material.

GRB DETECTIONS WITH CZTI

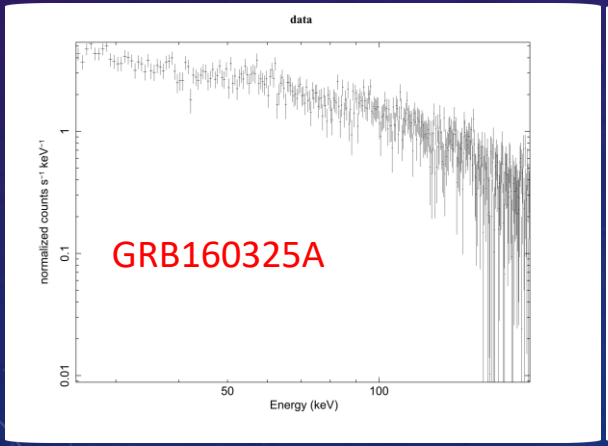
Direction

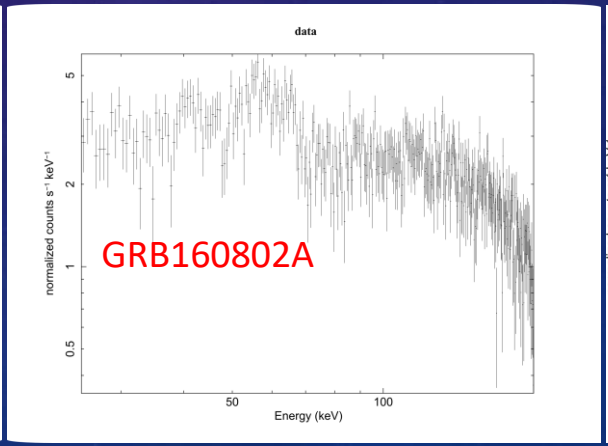


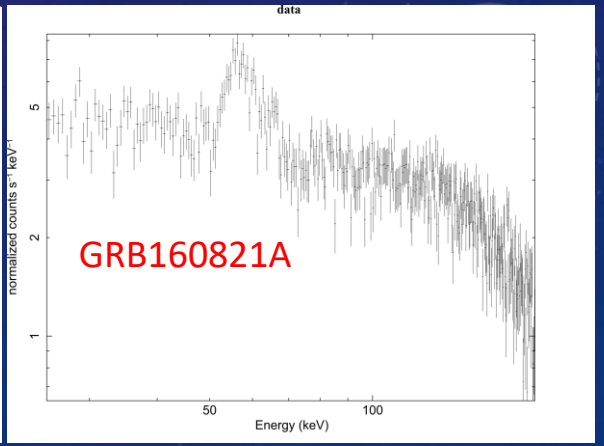




Energy







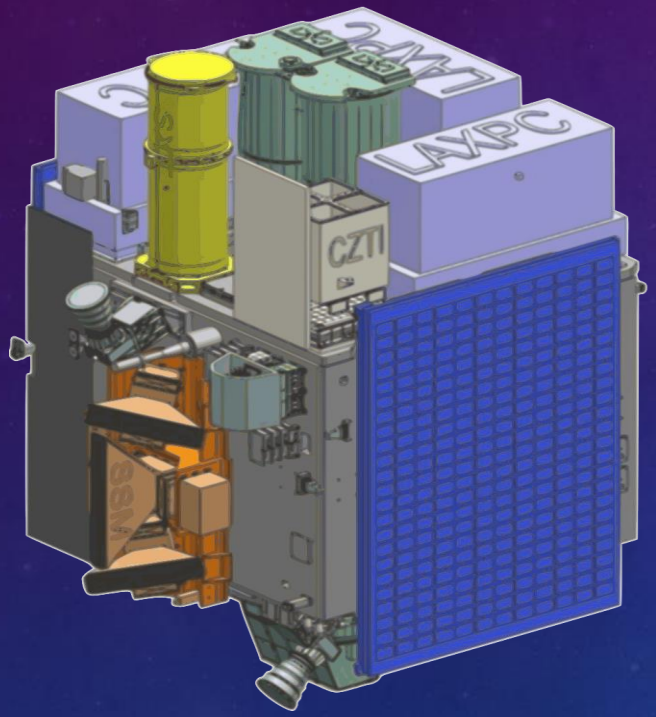
NEED FOR A MASS MODEL

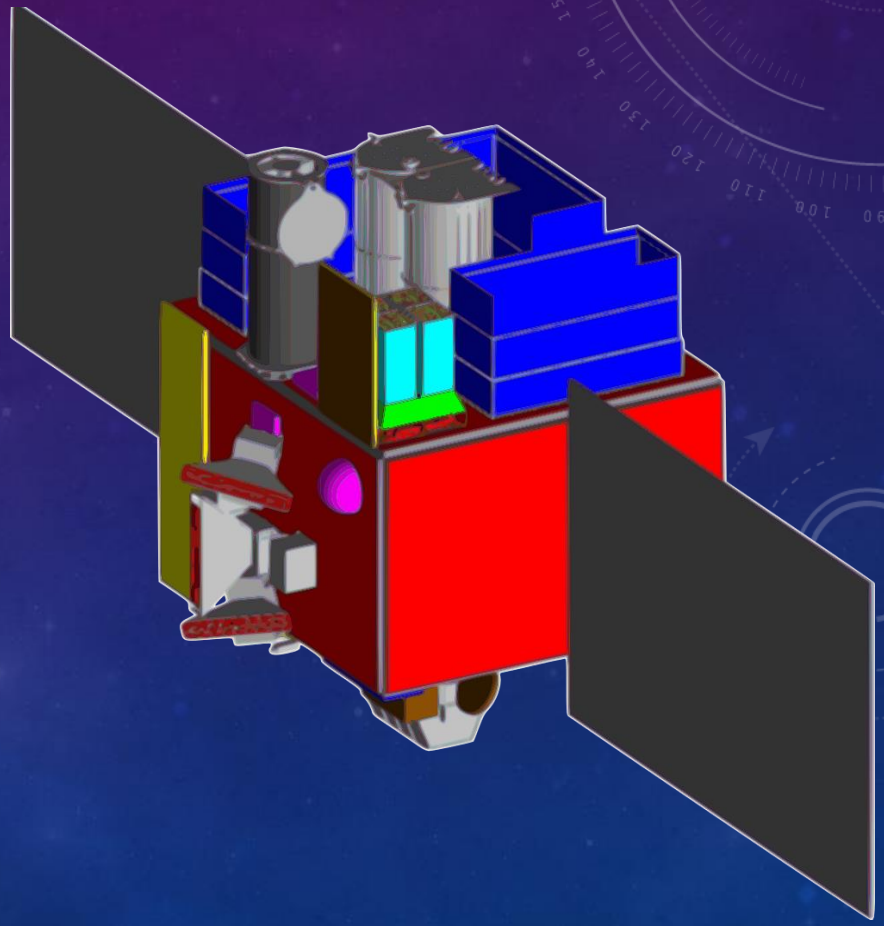
- This warrants a detailed modelling of the satellite and simulation of off-axis sources using this model.
- Such detailed chemical and geometrical modelling of an object is called a Mass Model.
- This enables:
  - Creation of response matrix for off-axis source → Spectral studies of GRBs
  - Localisation of off-axis source → Extremely important in case of LIGO trigger follow-ups.
- Non trivial task, requires detailed information about entire satellite also high computing power to carry out the simulations.

GEANT4 AS THE SAVIOUR

- GEANT4, a toolkit for particle, photons and matter interactions developed and maintained by CERN.
- Some salient features include
  - Predefined geometry classes which enables construction of complex geometrical structures in an easy way
  - Large material database and provision for custom material definitions by user
  - Simulation of all necessary physical processes as well as all kinds of particles
  - Tracking and extraction of particle properties and other parameters at any stage of simulation

HOW DOES IT LOOK?





VALIDATION AND RESULTS

- Validation with the 11 bright GRBs selected for the polarisation analysis by comparing observed and simulated data
- Method :
  - Simulation carried out for all GRBs in 100 – 500 keV range in steps of 5 keV
  - Output is scaled using band function using parameters from other missions (Konus-Wind in most cases at the moment)
  - Select photons detected in 100 – 150 keV. Same selection applied to the observed data.
  - Compared by plotting detector plane histograms and module-wise counts for simulation and data
- Work is still under progress with many GRBs showing qualitative agreement with few showing some discrepancies
- Complete results and details about mass model will be published in an article soon

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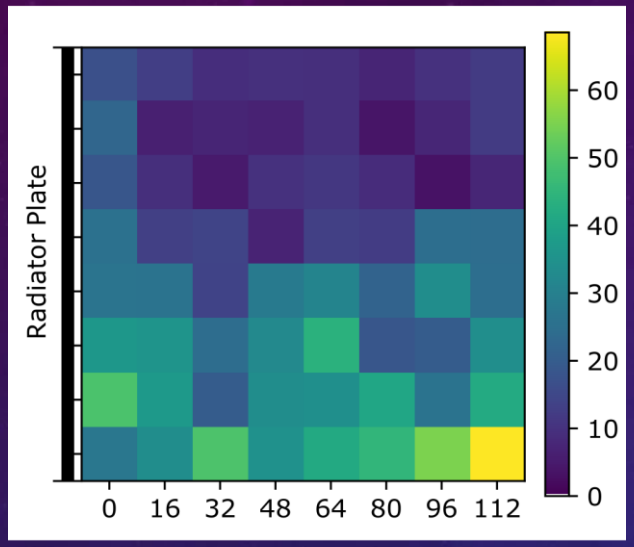
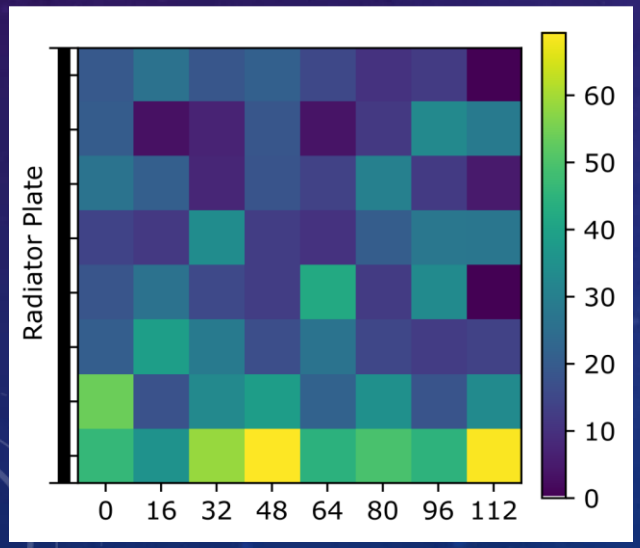
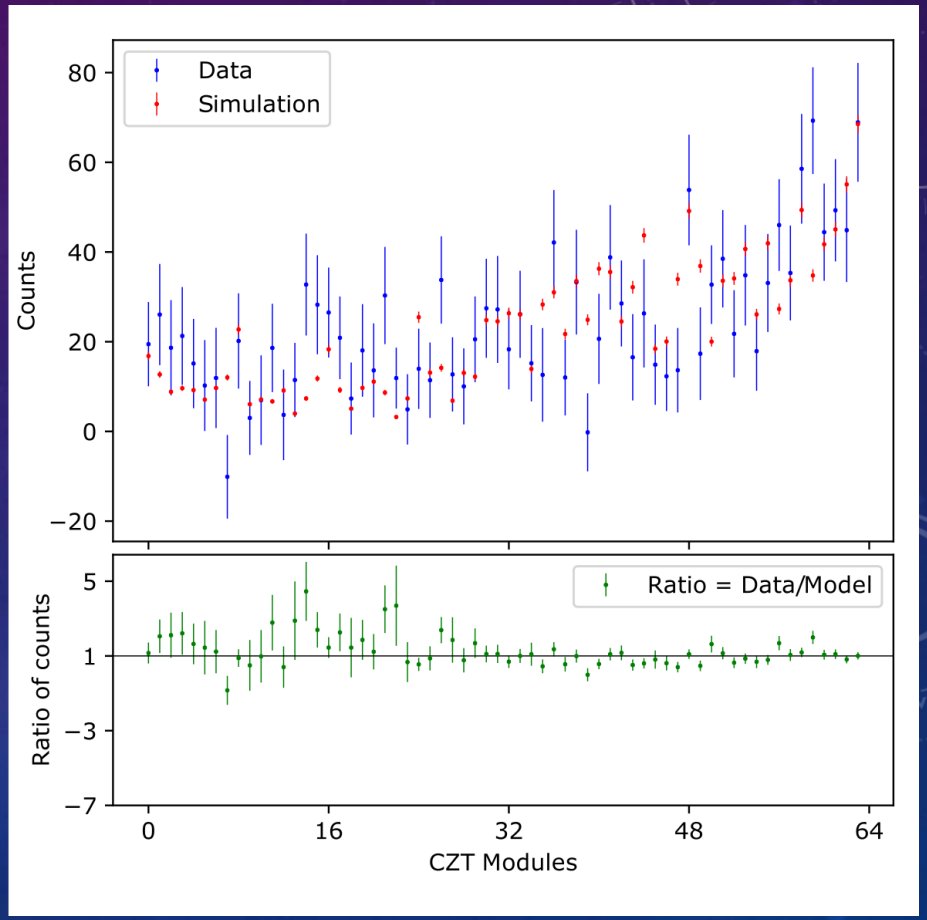


Simulation



Data



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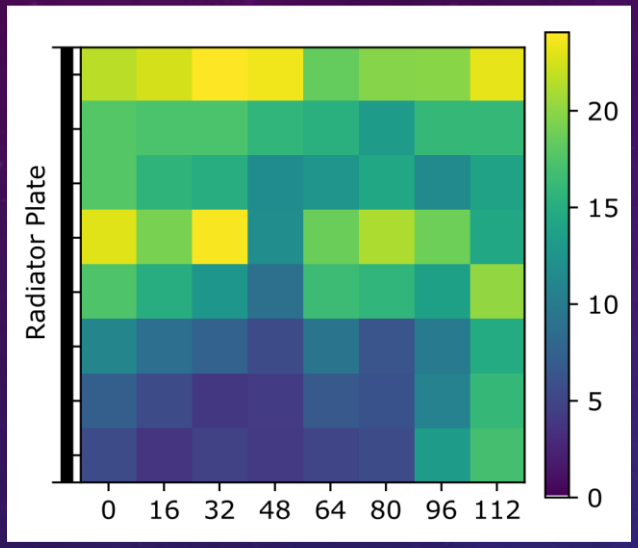
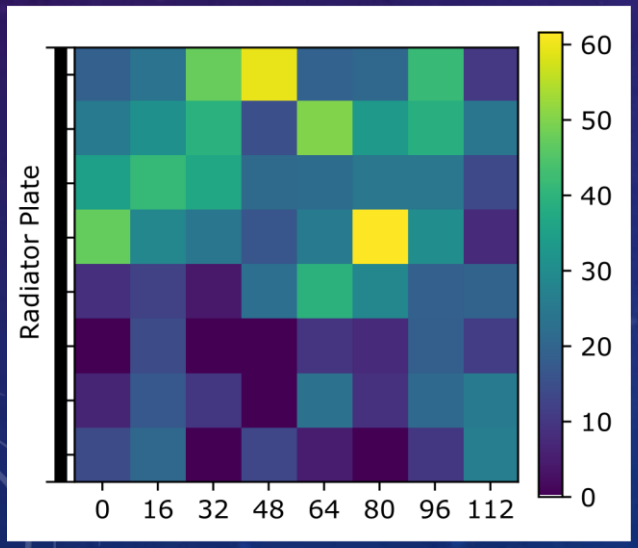
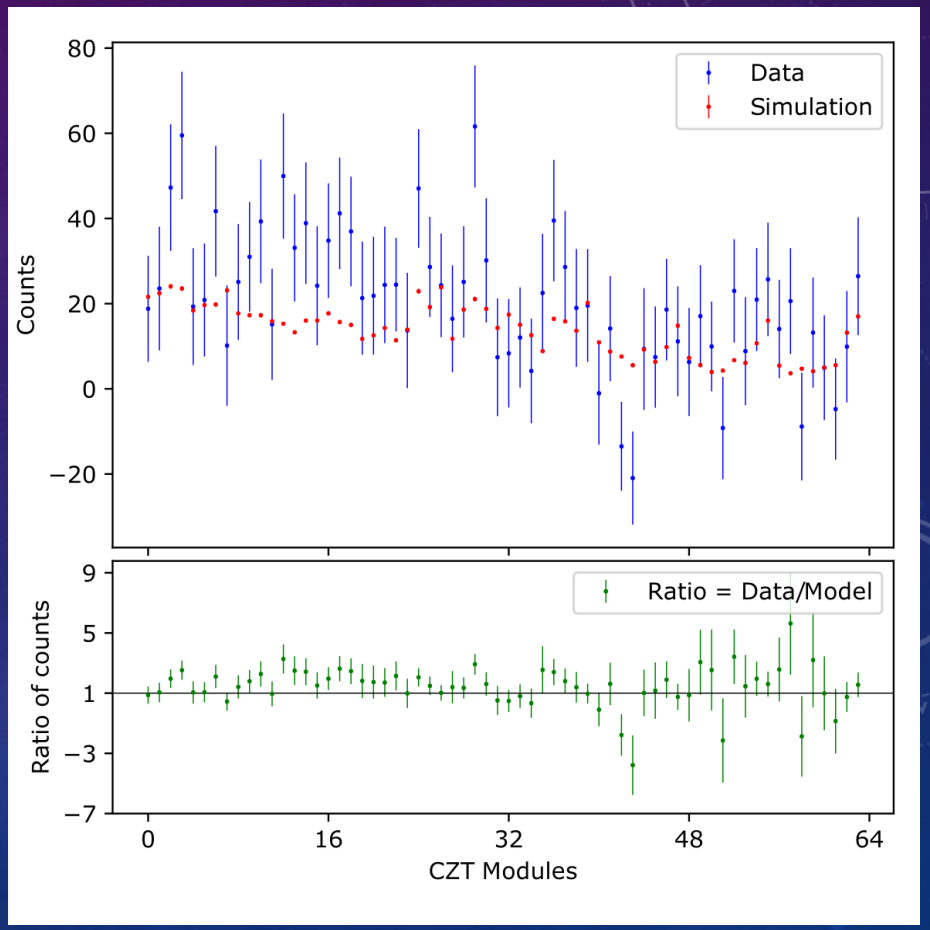


Simulation



Data



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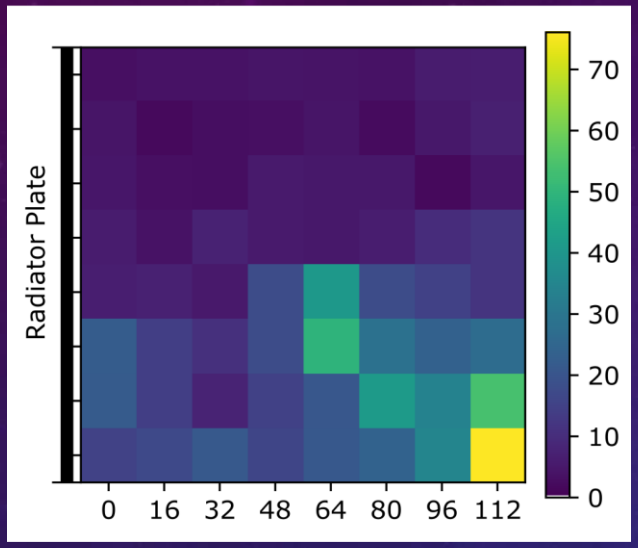
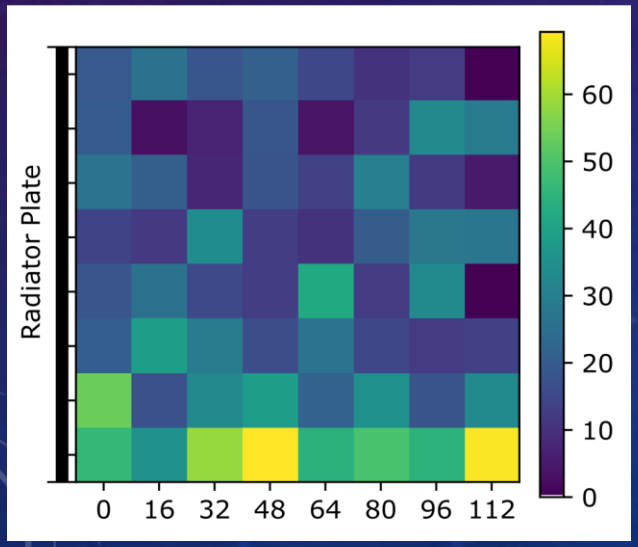


Simulation



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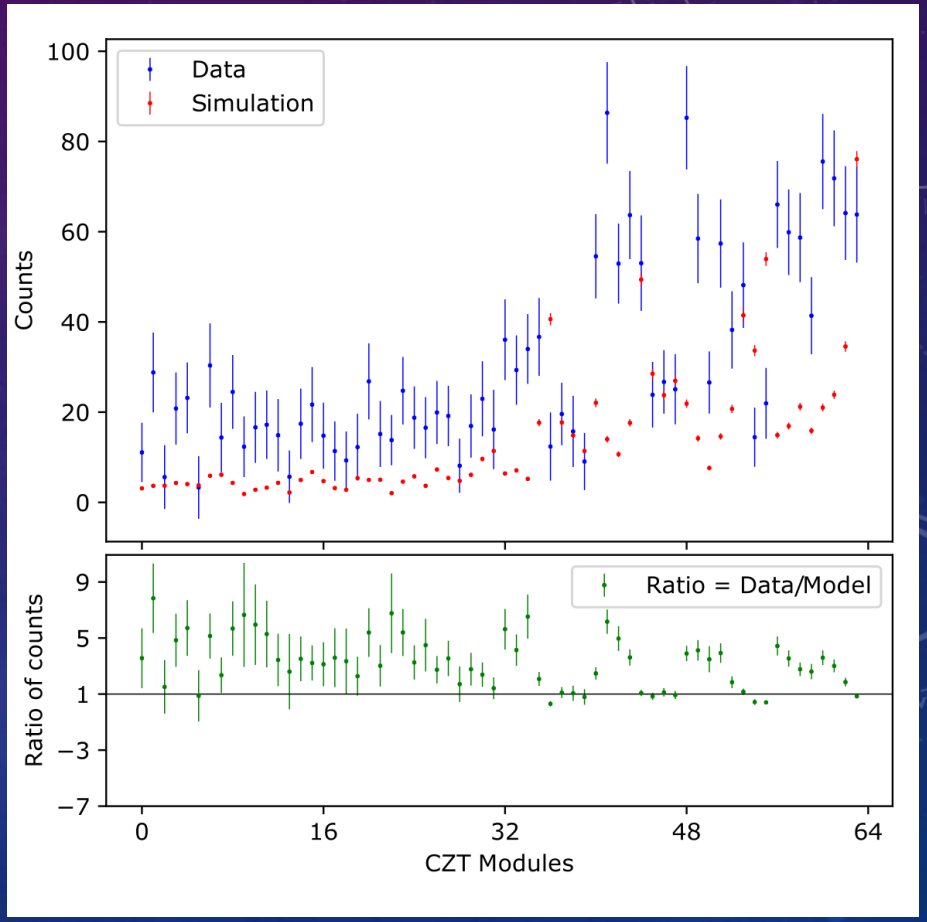

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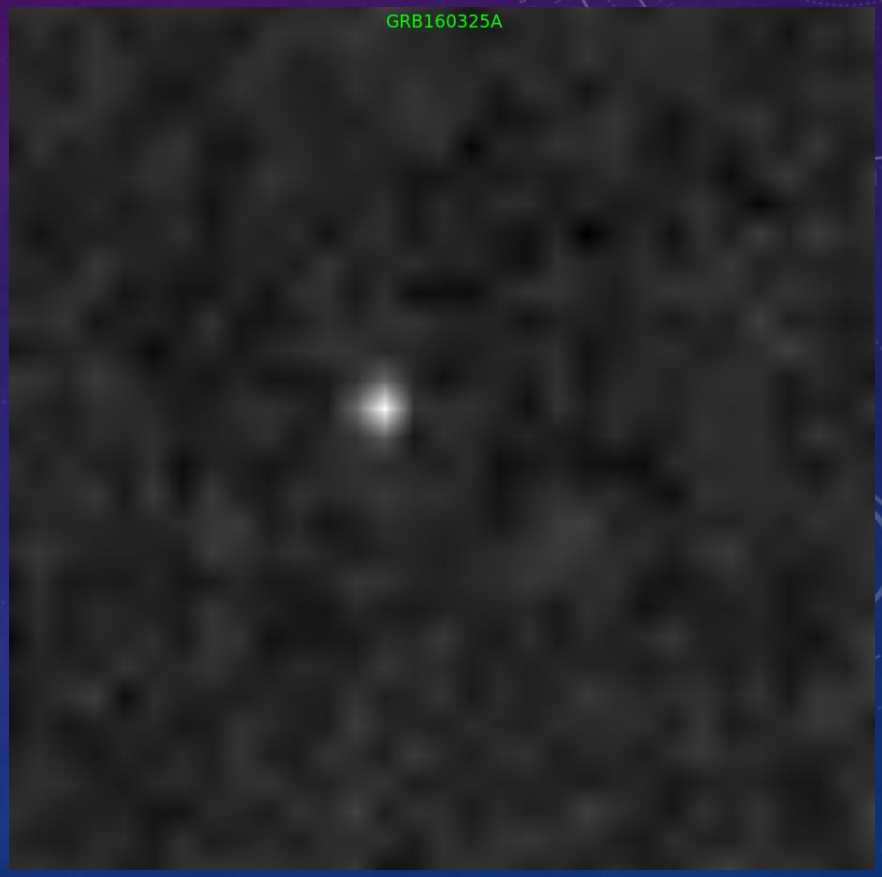
Simulation



Data

Credits : Ajay Vibhute

FUTURE DIRECTION

- Spectroscopic aspects
  - Creation of response matrix for these eleven bright GRBs and verification of spectral fitting
  - Creation of response matrix for all others GRBs with good statistics
  - Finding spectral parameters for GRB candidates in CZTI data

- Localisation aspects
  - Localisation of known GRBs by simulating grids close to the actual position
  - Localisation of GRB candidates
  - All sky response creation to follow-up LIGO triggers and carry out active localisation

Thank You